Space Weather Technical Forecast

Issued on Tuesday, 27 February 2024 at 00:46 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 remaining Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity recorded by GOES16 having been confined to low C-class and a peak flare of C3.6 at 26/0619UTC. This flare emanated from the largest and most complex sunspot group on the disc, AR3590. This group showed some slow changes in the period, however it remains a Zurich Fkc Mt Wilson Beta-Gamma-Delta, spanning a full 18 degrees of solar longitude and showing a large but stable penumbral area of 1640mhs. The main changes in this group in the 24 hours came as part of its leading cluster retrogressed into the region's central portion to reinforce the Mt Wilson delta spot(s) here, possible also enhancing the sigmoid shape magnetic flux seen in AIA171 and 094.

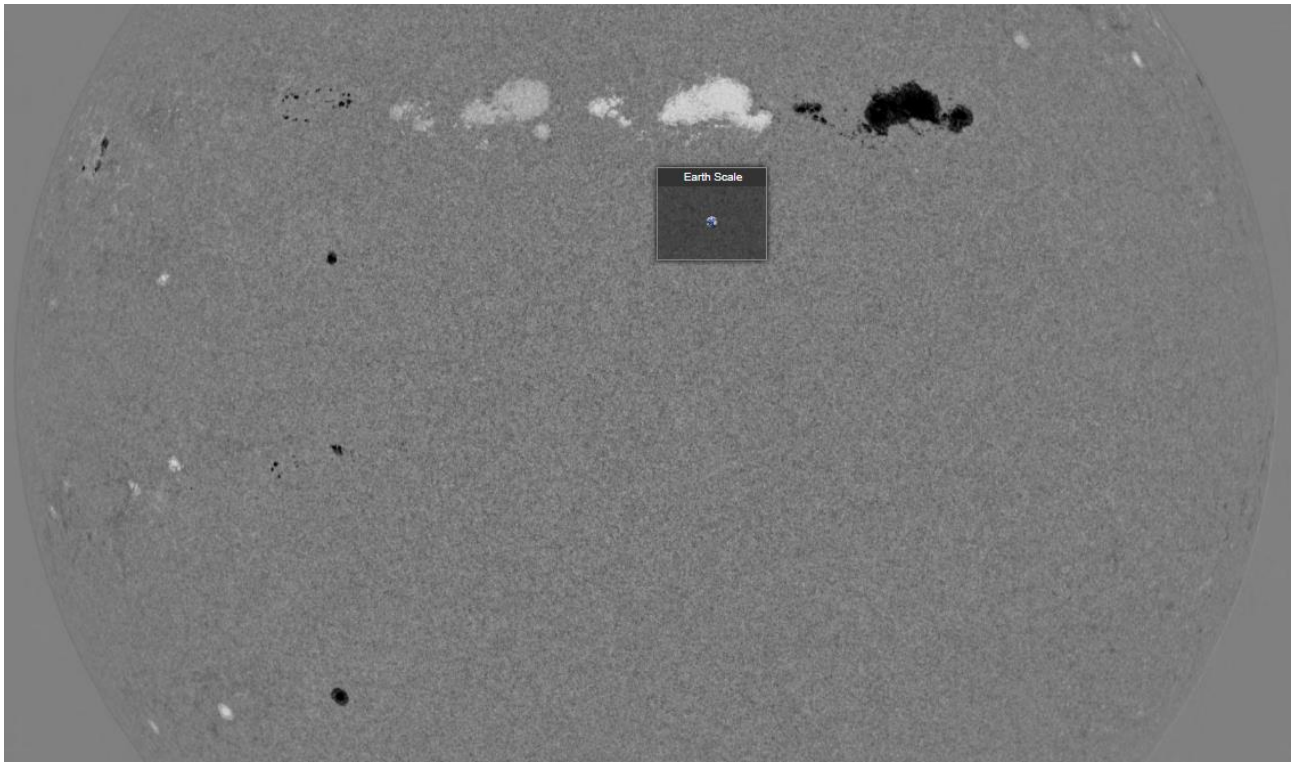

Figure 0: Helioviewer.org-generated HMIIF difference imagery showing the footprint of active regions at 26/2330UTC (black) and at previous 36-hour intervals in white (i.e. 25/1130UTC and 23/2330UTC). AR3590 dominates in the upper central portion of the disc.

The above was one of seven sunspot groups on the disc for a time, with a new group attaining a number in the form of AR3596 in the northeast which was assessed as a Dai/Beta, as AR3586 faded from view in the northwest as it neared the limb. Other spots paled in comparison to the main AR3590 (on paper), but the main trends were a spreading tendency in AR3595, and at the

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same time some consolidation in AR3596 to its east.

There were no Earth-directed Coronal Mass Ejections (CMEs) observed in available coronagraph imagery, with no significant movements in any of the front-sided filaments noted, and with activity confined to the off-going western limb and also the high latitude northeastern far side.

Solar Wind / Geomagnetic Activity: Solar winds, as recorded at L1 by ACE were reflective of the initial waning influence of a minor transient (since the UTC day of 24 February), followed by either a slow regime or weak coronal hole influence. This may have been capped by an SSBC after 26/2230UTC which lessens the likelihood of any CH01 influence, although it remains to be seen if this persists.

The phi angle has been largely negative (towards the Sun) in the past 24 hours, and although no conclusive entry into the fast wind of CH01/- was noted today or in preceding days, it is possible that this was masked by the transient and has been underway, else being very delayed.

Solar wind speeds have been Slightly Elevated, with a range between 425 and 375km/s, with the solar wind density near its long-term background in single figures ppcc. The IMF fell from early Slightly Elevated highs near 10nT to 5nT, before rising again late in the period, perhaps in relation to the possible SSBC. The north-south component initially calmed from an initial range between +8 and -9nT, although this opened out once again to end the period.

The net result of the above solar wind measures fell from early provisional highs of Kp 3+ in the 00-03UTC interval, else being Quiet.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at Background levels.

Electron flux (greater than 2MeV) observed at GOES16 has been at Normal Background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 27/0001UTC was 1.05e6 integrated pfu on a level trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are still Likely, with an ongoing Slight Chance of X-class. This risk is assessed as being constant through the four-day period, with the behaviour of AR3590 the dominant consideration.

Solar Wind / Geomagnetic Activity: No CMEs feature in the forecast. The only coronal hole fast wind due in the period is now either underway to little fanfare or else very late and is most likely to peak at Active geomagnetic activity or below, with the second half of the UTC working week still more reliably Quiet that the start (barring any CMEs).

Energetic Particles / Solar Radiation: Solar radiation storms of S1 and above are a rising Slight Chance day-on-day, with the main risk factor being any proton-rich flares from AR3590, which is nearing a potent position should it flare appropriately.

High energy electron flux and fluence are expected to follow similar trends throughout the coming four-day period, with the only driver to change this (CH01/-) now either underway to little effect, else late and consequently weaker. 24-hour integrated fluence should remain below Active throughout.

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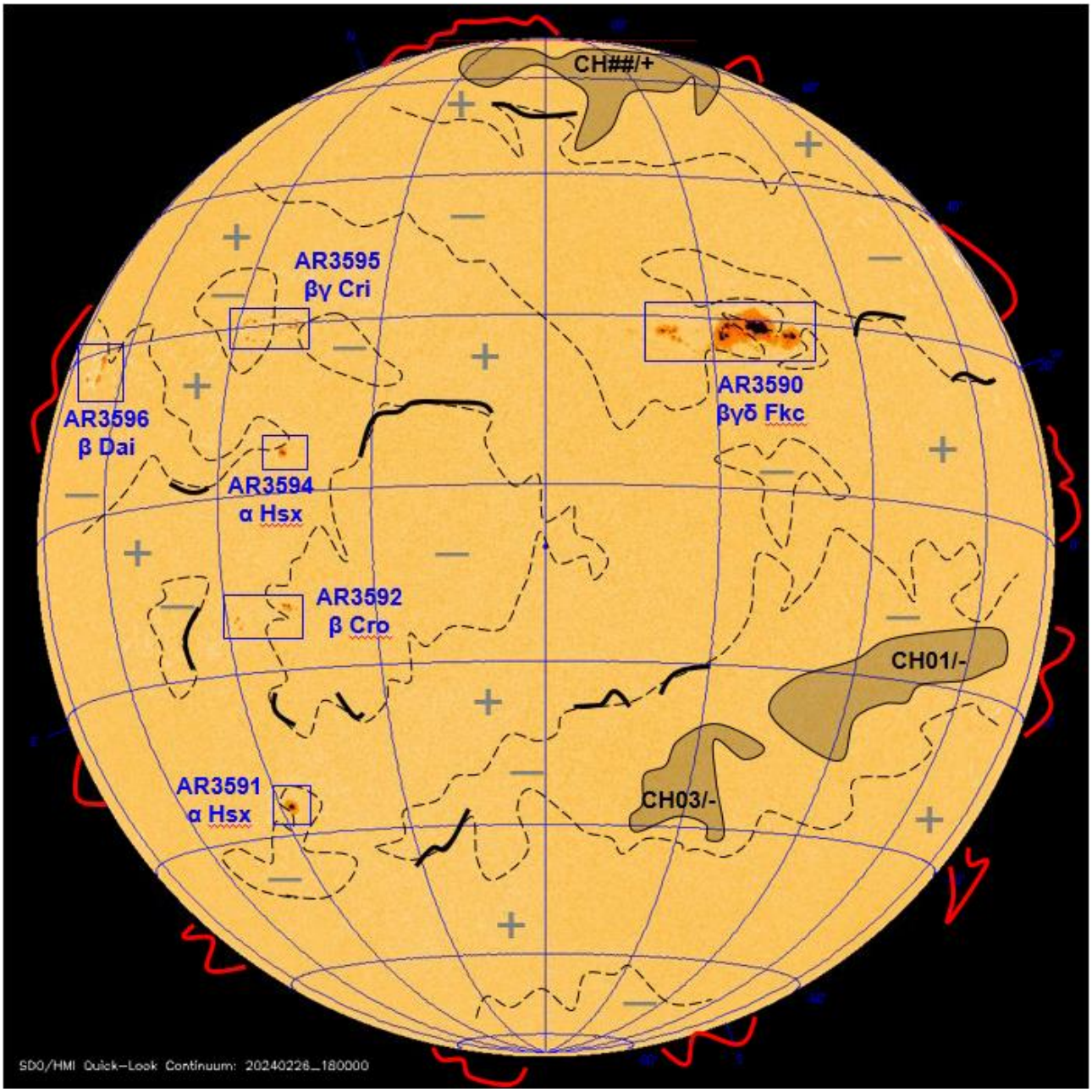
Figure 1. Solar Analysis Valid 26/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs feature in this forecast period.

The main coronal hole due in the period was expected to be CH01/- with speeds near 500km/s. Because of recent minor transient effects and the fact that the coronal hole is now overdue, it is now considered possible that either the coronal holes is already connecting with Earth with little consequence, else MOSWOC Enlil suggestions of the fast wind passing below the ecliptic plane may be correct. The third possibility is that the feature is still yet to arrive, however all three hypotheses lead to the same conclusion of a relatively lower risk of Elevated winds and Minor Geomagnetic Storms.

Geomagnetic activity is still likely to peak earlier in the current UTC working week, however the expected magnitude is now lower. More reliably Quiet conditions can be expected later in the four days, with any early peak activity perhaps now limited to isolated Active intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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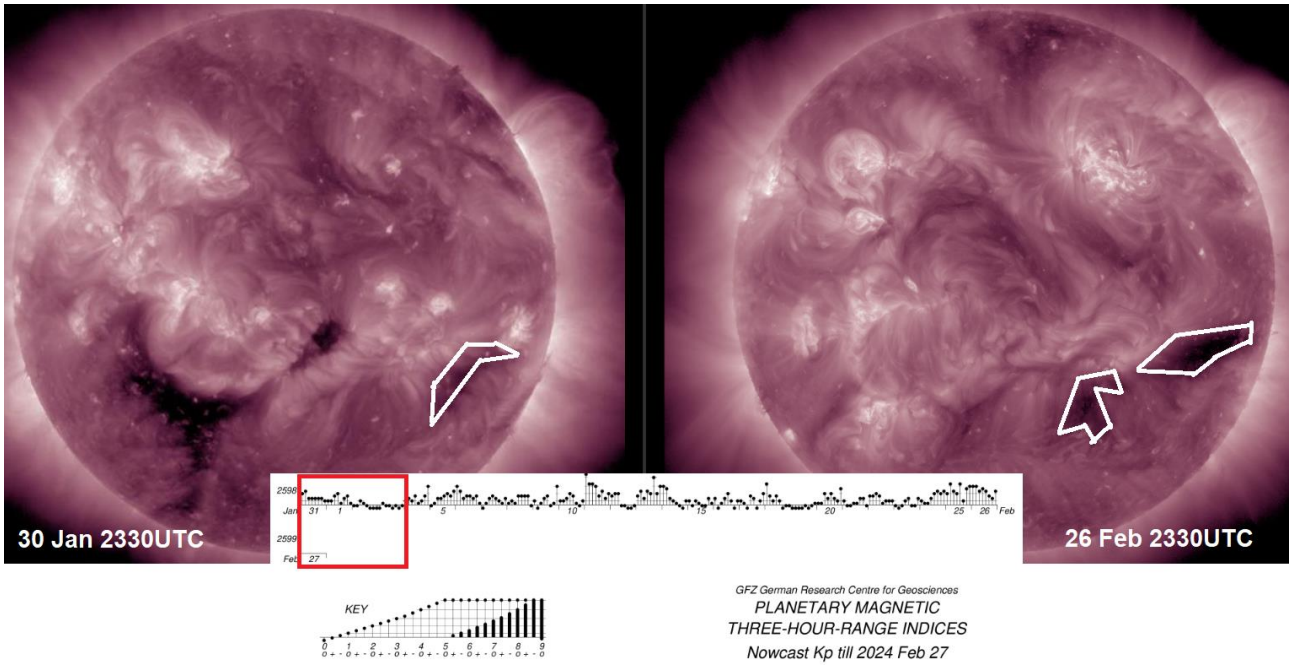
Figure 2: Current and past rotations' coronal hole configurations and resultant geomagnetic activity. CH01 does have an analogue from last pass, however it did not result in significant geomagnetism.



Radio Blackouts - X-Ray Flares:

The fortunes of the current disc are inherently tied to developments in AR3590. This sunspot group has had something of a Jekyll and Hyde-like character as it has progressed across the disc, periodically being capable of both very restrained flare activity near the B-C-class border, but also an unusually high cadence of large flares during its resurgences, producing two X-class flares on the same UTC day for example. The group currently appears to be undergoing something of a lull in flare activity, mirroed by a fall in Penticton flux from 181 to 172sfu in the most recent measurements, however it is felt that this cannot be relied upon to continue, and M-class flares are held as being Likely, with X-class a Slight Chance.

All of the current front-sided groups should remain on the Earth-facing disc in the period, and while there are suggestions of possible returning regions, these are not expected to rival the contribution from AR3590 in daily flare risk, and the chances of Moderate activity are held constant through the four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			**(%)**	**(%)**	**(%)**	**(%)**
Active	**R1-R2 M Class**	No	60	60	60	60
Very Active	**R3 to R5 X Class**	No	10	10	10	10

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Figure 3: SIDC ROB-processed X-ray flare trend of C-class and above at PROBA2 in the past 72 hours, showing the dominance of AR3590 but an overall declining potency.

Solar Radiation Storms - (High Energy Protons):

The current hiatus in activity from AR3590 and its historical lack of any proton enhancment visible at Earth from recent M and X-class flares means that the chances of S1 or greater are now considered slightly lower overall, although they do rise as this sunspot group migrates towards the better-connecting western limb should it flare appropriately. Contributions from other frontside spots are considered negligible - both due to their small stature, lack of flares, and occupancy of the eastern solar hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	20	20
Very Active	**≥ S3 ***	No	2	2	5	5

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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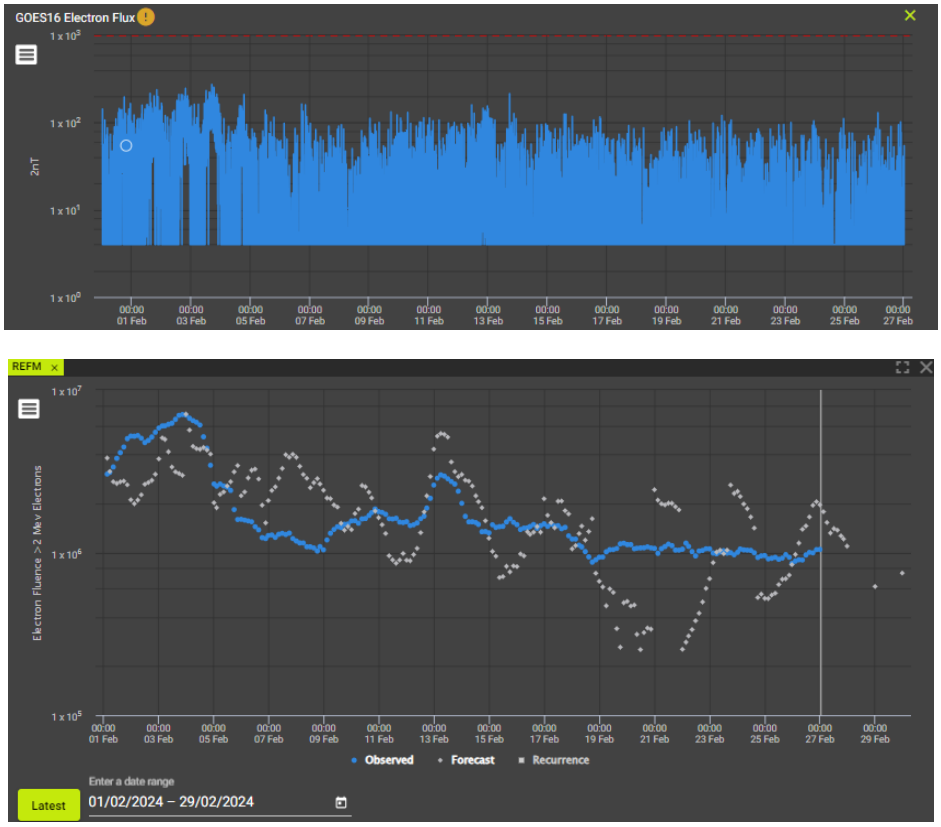
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is currently firmly rooted in Normal Background territory, and this trend is now expected to continue.

No feature of the past several rotations has proven capable of significantly raising electron populations at GEO, and with CH01/- either underwhelming or overdue and muted, the only real driver to change this now appears far less likely to be impactful. MOSWOC REFM's thoughts in persisting current 24-hour integrated electron fluence levels well below the Active threshold are therefore considered accurate and are followed here.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Past month in GOES16 high energy electron flux (top), showing persistently subdued populations of electrons at GEO. Also shown is 24-hour integrated fluence and MOSWOC REFM predictions. Note that even the top of this graph is a full decade below Active electron fluence.



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